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# GUIDE TO THE SALVAGE OF TEMPERATURE-ABUSED FOOD PRODUCTS IN MILITARY COMMISSARIES

BY

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A guide is proposed that would allow health personnel at military commissaries to select those foods that are salvageable from those that have to be rejected because of risk of foodborne illness as a consequence of refrigeration failure. The guide consists of three components. The first is the classification of the various chilled and frozen foods into three categories: "MELT", "SAFE", and "RISK". The second is the concept of temperature abuse tolerance (TAT) limits for RISK foods based on the lag times of three bacteria: Bacillus cereus, Staphylococcus aureus, and Salmonella. The third is the estimation of time interval and temperature to which RISK foods have been exposed. Thus, if the exposure of RISK foods to temperature abuse is within the TAT limits, then they are considered as salvageable.

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## PREFACE

From time to time, chilled and frozen foods in military commissaries are exposed to high temperatures (>7.2°C or 45°F) for several hours or even days as a consequence of refrigeration failure. Limited guidance has been available for risk assessment of these temperature abused foods, resulting in disposal of wholesome food because of the perceived risk of microbial infection and intoxication. The aim of the guide is to change this wasteful practice to one which selects those foods that are salvageable from those that have to be rejected because of risk of foodborne illness. In addition, these food items are also categorized based on a rough estimation of their stability to spoilage when exposed to abuse temperatures. The only laborious portion of the salvaging process is the temperature determination of food batches affected by refrigeration failure. This work was undertaken during the period November 1984 to September 1987 and was supported by Program 1461 (AAF87-12, II).

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# GUIDE TO THE SALVAGE OF TEMPERATURE-ABUSED FOOD PRODUCTS IN MILITARY COMMISSARIES

## I. INTRODUCTION

This guide serves to select food products that can be salvaged from those that have to be condemned when refrigeration fails. The need for the guide came about from the realization that products exposed to abuse temperatures have been thrown out unnecessarily in the past because of public health concern. The concern is that increases in temperature of certain foods would allow the growth of bacterial pathogens and/or the production of toxins. This proposed procedure classifies potentially hazardous foods ("RISK" foods) from those that present no public health risk ("SAFE" foods). In addition, "RISK" foods have varying time/temperature limits of abuse within which there are no public health concerns. These limits are reached long before the "RISK" products exhibit any significant deterioration.

Besides the primary concern of risk of foodborne illness, the guide also addresses in general terms the concern of overall quality deterioration of temperature-abused foods in order to minimize the likelihood of military consumers purchasing products that have undergone significant deterioration. However, the area of quality or consumer acceptance is so complex that the retailer or commissary officer should be given great latitude as far as the marketability of "SAFE" foods is concerned.

There are three essential determinations that are needed to assess the salvageability of thermally distressed foods in the commissary. These are: (1) duration of abuse, (2) the type of products involved, and (3) the final temperature of the product.

The most laborious portions of the guide are the temperature readings and decision making. For ease of use, this portion is divided into two sections. The simplified form (Section VI) is appropriate whenever small lots are involved or refrigeration failure occurrence is of short duration. The long form version (Section VII) is more discriminating for large food lots, especially when these are exposed to elevated temperatures for long time periods.

## II. TOOLS

Included with the guide is a blank form (Appendix A) on which the required data are entered. These include: (1) the time and date of refrigeration failure; (2) the time interval of refrigeration failure, and (3) the temperature limits of the three types of "RISK" foods based on (2) and Table 2. The acquisition of all these data in one form provides for a convenient and systematic procedure for assessing the fate of the affected products.

In the first column of the blank form, write the names of the temperature-abused products under consideration including the sizes and prices per unit. The classifications and corresponding temperature limits (TL) are entered in the second column. In the third column, write down the temperature readings (TRs) obtained from packages being sampled; these are compared with the temperature limits written in column two to determine their acceptability (+ or -). Write down the number of units involved on the second to the last column and the number of units saved on the last column.

Other requirements for deciding the fate of temperature abused foods are: (1) a timepiece (2) a ruler (3) a waterproof marking pen, (4) paper towels and (5) a calibrated thermometer that has an accuracy of $\pm$ 1°F, which indicates the uses of an electronic digital thermometer. A bi-metallic/dial thermometer may also be used.

III. ESTIMATION OF THE TIME PERIOD OF REFRIGERATION FAILURE

The estimation of the time period of refrigeration failure is usually simple. Commissaries may be equipped with electronic warning devices that not only trigger an alarm but also record the time when refrigeration failure occurs.

In cases where such devices are either unavailable or malfunctioning, one should assume the worst case scenario of refrigeration failure occurring just shortly after the last person has left the commissary.

The time of occurrence of a power outage may be deduced from the stoppage of an electric clock or from the testimonies of people or, if it was a general blackout, by an inquiry of the electric company.

IV. CLASSIFICATION OF FOOD PRODUCTS WITH THE AID OF TABLE 1

For purposes of determining salvage possibilities, refrigerated food products are grouped into four sections as shown in Table 1: (1) the dairy section, (2) the meat section, (3) the bakery section, and (4) the fruit/vegetable section. These are further subdivided into frozen and chilled products. The names of the products are listed on the second column and their classification or "food type" on the third column. The product listing will need to be revised periodically to take into account new products that may be available to the consumer.

One of the three general categories of products is "MELT". Foods classified in this group become unacceptable when thawed because the products develop structural changes that are not appealing to the consumer. Also included in this group are those products that when defrosted in horizontal cabinets become mashed by the weight of packages on top of them. Consequently, thawed products of this category should be rejected outright.

"SAFE" foods present no public health hazard as a consequence of temperature abuse. The only concern is quality. This category can be further subdivided into four groups. The items in the first group (SAFE-1) are those that are microbiologically stable at room temperature but are nevertheless stored in chilled cabinets. These foods should be salvaged without concern regarding diminished shelf-life.

Refrigeration of other "SAFE" foods (SAFE-2, SAFE-3, and SAFE-4) is primarily to increase the shelf-life of these products. Products prepared at the retail level, such as fruit salads, are the least stable (SAFE-4 category).

Information regarding the categories of "SAFE" foods and the time-temperature abuse that they have suffered should help the retailer in assessing the marketability of these products. Again, the retailer should be given great latitude in judging the marketability of these products. Retailers should likewise be aware of the diminished shelf-life of all salvaged temperature-abused foods except SAFE-1 foods.

TABLE 1. List of Chilled and Frozen Food Products, Grouped Into Four Major Sections and Classified Into Food Types (MELT, SAFE-1, 2, 3, 4 and RISK-1, 2, 3).

| 1. Baked Goods Sect | Food Type* |
|---|---|
| 1.1 Frozen | |
| 1. Dough, ready-to-bake | SAFE-2 |
| 2. Pie crust | " |
| 3. Pastries, no filling of cream, custard, meat | " |
| 4. Pizza, cheese or pepperoni | " |
| 5. Popcorn | " |
| 6. Pastries filled with cream, custard, meat (e.g. Boston Cream Pie, cakes, croissants) | RISK-3 |
| 1.2 Chilled | |
| 1. Yeast, baker's | SAFE-1 |
| 2. Dough, ready-to-bake | SAFE-2 |
| 3. Pie crust | " |
| 4. Tortilla | " |
| 5. Pastries, no filling of cream, custard meat | SAFE-3 |
| 6. Pastries, filled with cream, custard, meat | RISK-3 |

*Food type category numbers indicate SAFE-1 for products and conditions that result in least food spoilage upon refrigeration time-temperature interruption and SAFE-4 for highest chance of spoilage. See Table 2 for RISK category description.

TABLE 1. (Continued) List of Chilled and Frozen Food Products, Grouped Into Four Major Sections and Classified Into Food Types (MELT, SAFE-1, 2, 3, 4 and RISK-1, 2, 3).

| 2. Dairy Section | Food Type |
|---|---|
| 2.1 Frozen | |
| 1. Ice cream, ice milk, sherbet, ice cream sandwich | MELT |
| 2. Popsicles | " |
| 3. Cream | RISK-3 |
| 2. Dairy Section | |
| 2.2 Chilled | |
| 1. Butter | SAFE-2 |
| 2. Cheese, processed | " |
| 3. Cheese, ripened, hard & semi-hard types | " |
| 4. Lard | " |
| 5. Margarine | " |
| 6. Buttermilk | SAFE-3 |
| 7. Cream cheese | " |
| 8. Dips, sour cream base | " |
| 9. Eggs in shell | " |
| 10. Sour cream | " |
| 11. Yogurt | " |
| 12. Pickled herring, shrimp | RISK-1 |
| 13. Cheese, cottage cheese | RISK-2 |
| 14. Cheese mold ripened, semi-hard | " |
| 15. Cheese | " |
| 16. Cheese, Camenbert | RISK-3 |
| 17. Cheese, Brie | " |
| 18. Cheese, mold-ripened, soft | " |

TABLE 1. (Continued) List of Chilled and Frozen Food Products, Grouped Into Four Major Sections and Classified Into Food Types (MELT, SAFE-1, 2, 3, 4 and RISK-1, 2, 3).

| 3. Fruit/Vegetable | Food Type |
|---|---|
| 3.1 Frozen | |
| 1. Strawberry | MELT |
| 2. Fruit juices and concentrates | SAFE-2 |
| 3. Fruits | " |
| 4. Blueberry, raspberry | SAFE-3 |
| 5. Vegetables, uncooked, blanched | SAFE-4 |
| 6. Onion rings, precooked | RISK-3 |
| 7. Vegetables, precooked | " |
| 3.2 Chilled | |
| 1. Fruit juices ("refrigerate after opening") | SAFE-1 |
| 2. Salsa ("refrigerate after opening") | " |
| 3. Fruit in syrup, wholesaler-processed | SAFE-2 |
| 4. Horseradish sauce | " |
| 5. Lemon juice, undiluted | " |
| 6. Pickled or maintained vegetables | " |
| 7. Salad dressing | " |
| 8. Sauerkraut | " |
| 9. Fruit juices, not lemon | SAFE-3 |
| 10. Fruits, fresh, cut-up, retail | SAFE-4 |
| 11. Vegetable/fruit salad, retail | " |

TABLE 1. (Continued) List of Chilled and Frozen Food Products, Grouped Into Four Major Sections and Classified Into Food Types (MELT, SAFE-1, 2, 3, 4 and RISK-1, 2, 3).

| 4. Meat | Food Type |
|---|---|
| **4.1 Frozen** | |
| 1. Pot pies | MELT |
| 2. Meat, cured/salted | RISK-2 |
| 3. Poultry, cured/salted | " |
| 4. Sausages, not fermented | " |
| 5. Fish shellfish, raw | RISK-3 |
| 6. Fish and shellfish dished, precooked | " |
| 7. Meat, raw, uncured/unsalted | " |
| 8. Meat dishes, precooked | " |
| 9. Poultry, raw | " |
| 10. Poultry dished, precooked | " |
| **4.2 Chilled** | |
| 1. Bacon bits ("refrigerate after opening") | SAFE-1 |
| 2. Bacon, country cured, unsliced | " |
| 3. Ham, canned ("refrigerate after opening") | " |
| 4. Ham, country cured, unsliced | " |
| 5. Luncheon meats, sliced ("refrigerate after opening") | " |
| 6. Pepperoni, fermented sausage | " |
| 7. Salami, hard, genoa, fermented sausage | " |
| 8. Sausage, fermented | " |
| 9. Ham, canned ("keep refrigerated") | RISK-1 |
| 10. Cured/salted meats and poultry | RISK-2 |
| 11. Salted fish | " |

TABLE 1. (Continued) List of Chilled and Frozen Food Products, Grouped Into Four Major Sections and Classified Into Food Types (MEIT, SAFE-1, 2, 3, 4 and RISK-1, 2, 3).

| 4. Meat (Continued) | Food Type |
|---|---|
| 4.2 Chilled (Continued) | |
| 12. Fish and shellfish, raw | RISK-3 |
| 13. Fish and shellfish, dished, precooked | " |
| 14. Meat, raw, uncured/unsalted | " |
| 15. Meat, dished, precooked | " |
| 16. Poultry, raw | " |
| 17. Poultry, dishes, precooked | " |
| 18. Vegetable dishes | " |

"RISK" foods or what are often referred to as potentially hazardous foods are those that present a danger to consumers. These are subdivided into three groups (RISK-1, RISK-2, and RISK-3). Each of these categories exhibits certain time-temperature limits of abuse within which there is no public health concern. One refers to Table 2 to determine the temperature limit for each category of RISK foods based on the estimated time interval of exposure to high temperatures. For instance, if refrigeration failure occurred in a 20 h period, goods classified as RISK-1 (pasteurized canned ham) are salvaged if their final temperatures did not exceed 19°C (66°F). Foods classified as RISK-2 such as luncheon meats are salvageable if their temperatures did not exceed 15°C (59°F). For RISK-3 foods such as ground beef, the temperature limit is 12°C (54°F).

TABLE 2. Time-Temperature Limits for RISK Foods Judged as Salvageable When Refrigeration Fails.

| TIME INTERVALS FOR THREE TYPES OF RISK PRODUCTS (HRS) | | | FINAL TEMPERATURE OF PRODUCTS ($^{O}C/^{O}F$) |
|---|---|---|---|
| RISK-1 | RISK-2 | RISK-3 | |
| >72 | >72 | (54)* | 8/47 |
| >72 | 72 | (46-53)* | 9/48 |
| 72 | 61-71 | 31-45 | 10/50 |
| 59-71 | 52-60 | 22-30 | 11/52 |
| 47-58 | 28-51 | 19-21 | 12/54 |
| 39-46 | 32-37 | 13-18 | 13/55 |
| 31-38 | 23-31 | 10-12 | 14/57 |
| 29-30 | 17-22 | 8-9 | 15/59 |
| 26-28 | 15-16 | 7 | 16/61 |
| 24-25 | 14 | 7 | 17/63 |
| 21-23 | 13 | 6 | 18/64 |
| 19-20 | 12 | 5 | 19/66 |
| 17-18 | 11 | 5 | 10/68 |
| 15-16 | 10 | 4 | 21/70 |
| 13-14 | 9 | 4 | 22/72 |
| 11-12 | 8 | 3 | 23/73 |
| 9-10 | 7 | 3 | 24/75 |
| 7-8 | 7 | 2 | 25/77 |

*Based on microbial spoilage

## V. TARGETING FOR SAMPLING SITES

### A. Stacking Arrangement of Food Lots

Food products in refrigerated display cabinets are divided into food lots that consist of stacks of several packages of the food item of the same size. Before temperatures of lots are determined, it is important for ease of sampling to begin with a food lot that has a cubic configuration of a lot with stacks of uniform height as depicted in Fig. 1, A ("A" configuration).

In many instances, one is likely to encounter food lots that differ in varying degrees from the "A" configuration. Therefore, one should be ready to manipulate a food lot without disturbing the position of the remaining packages that constitute the lot. Manipulation may include: (1) the removal of the outer packages or stacks from the lot to be discarded in order for the lot to emerge with an "A" configuration, (2) the splitting of a lot into two or more smaller lots such that each resulting lot has an "A" configuration, and (3) the use of a combination of (1) and (2).

Fig. 1, B depicts a lot with stacks of uniform height (H-1) except for one stack (H-2) which is shorter by one package. To obtain a lot with an "A" configuration, one simply removes and discards the stack of three packages.

A lot is depicted in Fig. 1, C that contains stacks of four packages at the rear portion and stacks of three packages at the front portion (H-2). On the basis of height, one may divide the lot to obtain two lots each with an "A" configuration. A more convenient way is to remove the top packages from the taller stacks (H-1) to obtain a lot with an "A" configuration.

Fig 1, D shows a lot consisting of stacks with three different heights. The front end (H-3) is composed of the shortest stack while the back end (H-2) is composed of the taller stacks except for one stack (H-1), which is taller by one package. The manipulation of this lot involves a combination of the removal of the top package from the tallest stack and the division of the lot into two lots--a lot of four layered stacks and a lot of two layered stacks.

B. Segmentation of Food Lots

1. Simplified Form

A food lot can be viewed as layers of packages (see Fig 1A). This segmentation serves to emphasize the significance of each layer of the lot in estimating the exposure of each package to high temperatures. In a power failure, when all electrical systems are off, a temperature gradient emerges with the bottom layer being the coldest. On the other hand, the middle layer is the coldest portion of the lot during a mechanical failure when the compressor is no longer operative but the fans and the defrosting element are still functioning.

For the sake of convenience, little significance is attached to the difference in temperature between the outer or side packages and the inner or core packages of a lot. Yet one can intuitively see that the core packages of a lot are always colder than the side or outer packages.

2. Long Form

The long form technique further subdivides the lot not only into layers but also into two groups: (1) the side (S) packages or stacks that form the sides or rim of the lot and (2) the core (C) packages or stacks that are ringed by the S packages or stacks.

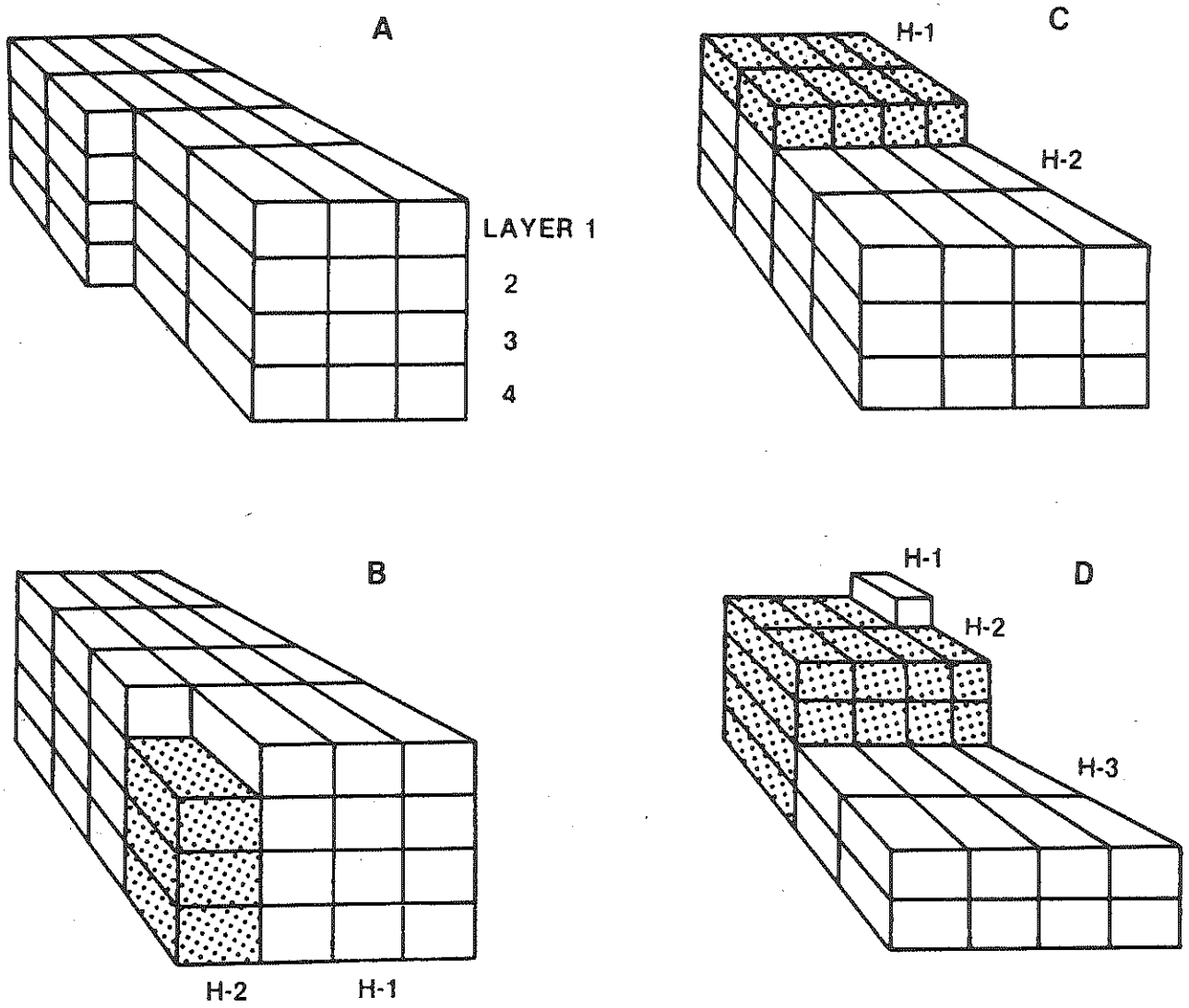


Figure 1. Stacking arrangement of food lots in regard to variation in stacking levels. Except for lot A, which has a uniform stacking arrangement ("A" configuration), lots B, C, and D consist of two or more groups with regard to stack heights.

There are physical and time constraints in choosing the long form over the simplified form for the sampling of lots. Fig. 2 shows that lot A whose sides (L X W) have 2 X 3 stacks has no C stacks. Lot B, which has 3 X 3 stacks, has only one C stack. The smallest lot that the long form approach is applicable to is one which has sides of 3 X 4 stacks. In this case, lot C, there are two C stacks, one of which can be used as the sampling stack or the stack form. Similarly, lot D contains four C stacks.

C. Specific Sampling Sites of Food Lots for Temperature Readings.

The major factors that determine the selection of the temperature reading (TR) sites are (1) the type of refrigeration failure (power or mechanical) and (2) the choice of a simplified or a long form of sampling.

1. Power Failure

a. Simplified Form

Two corner stacks of a lot that are likely to be most exposed to high temperatures are selected as the sampling stacks (Fig. 3). Each package of the sampling stacks represents a particular layer of the lot. For instance, the top and bottom sampling packages of the sampling stack represent the top and bottom layers of the entire lot, respectively. The site for each TR is on the upper, outer corner of each sampling package regardless of thickness. In the case of a four-layered lot, duplicate sites of TRs 1 - 4 are shown in Fig. 3.

b. Long Form

In addition to the two corner sampling stacks, which in this case represent only the S packages, a sampling stack that is likely to be most exposed to high temperatures is selected among the C packages. The site for each TR is similar to the corner sampling stacks (see Fig. 3).

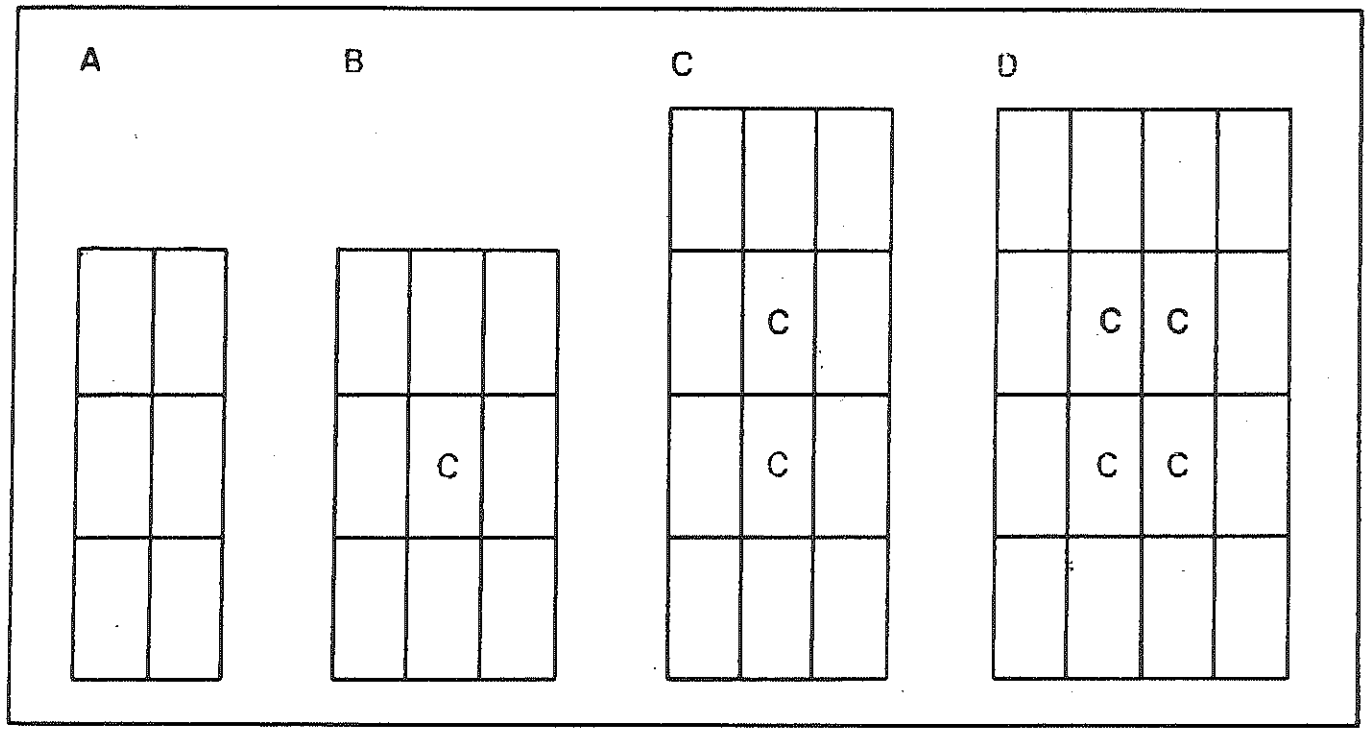


Figure 2. Schematic representation of various sizes of lots as viewed from the top. Lot A has no core (c) stack, Lot B has one core stack, Lot C has two core stacks and Lot D has four core stacks.

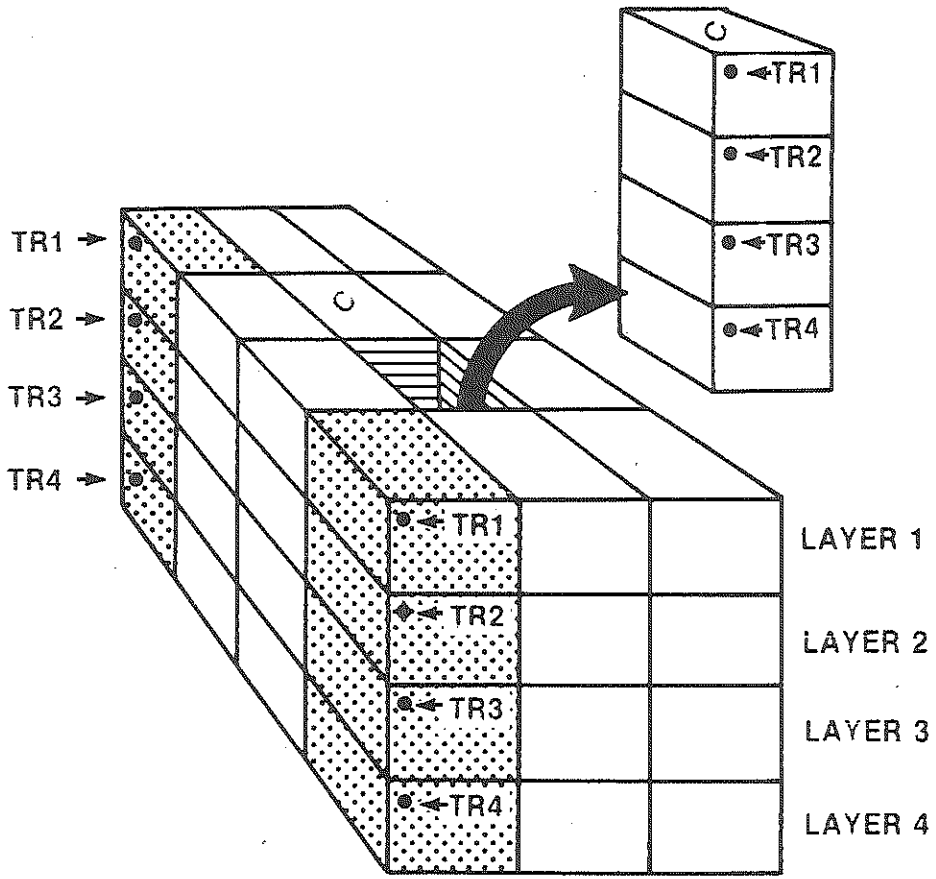


Figure 3. Schematic representation of three sampling stacks of a food lot for use with either the short or the long for sampling strategy. Only two of the four corner stacks are used for the simplified sampling strategy (S sampling stacks).

2. Mechanical Failure

Selecting for specific sampling sites in this case is more complicated since the thickness of the package and the number of packages/stack have to be taken into consideration.

a. Simplified Form

(1) Thick packages (those that exceed three inches): The sampling sites for the two corner sampling stacks is illustrated in Fig 4, B. For lots consisting of four or more layers, write "1" on the upper side corner of each sampling package and "2" on its lower side. (If necessary, wipe the surface dry with a paper towel before writing the numbers). For the next sampling package underneath, write "3" on its lower outer corner. For the bottom sampling package, write "4" and "5" on the upper and lower outer corner, respectively. For lots consisting of one and two layers, the sampling sites are, of course, limited. The TR2 sampling site generally represents the lower portion of the top layer and the top portion of the next layer with the exception of a lot with one layer. Similarly, TR3 represents the lower portion of the layer next to the top as well as the top portion of the third layer of a lot except a two-layered lot. With exception of a three-layered lot, TR4 represents both the top portion of the bottom layer and the bottom portion of the layer above the bottom layer of the lot. The process of marking and measuring temperatures of the packages would require the removal of the sampling stacks.

(2) Thin packages (three inches thick or less): The location of the sampling sites is shown in Fig. 4, B. For lots consisting of 5 or more layers, write "1" on the outer side corner of each sampling package equidistant from the top and bottom cover of the package.

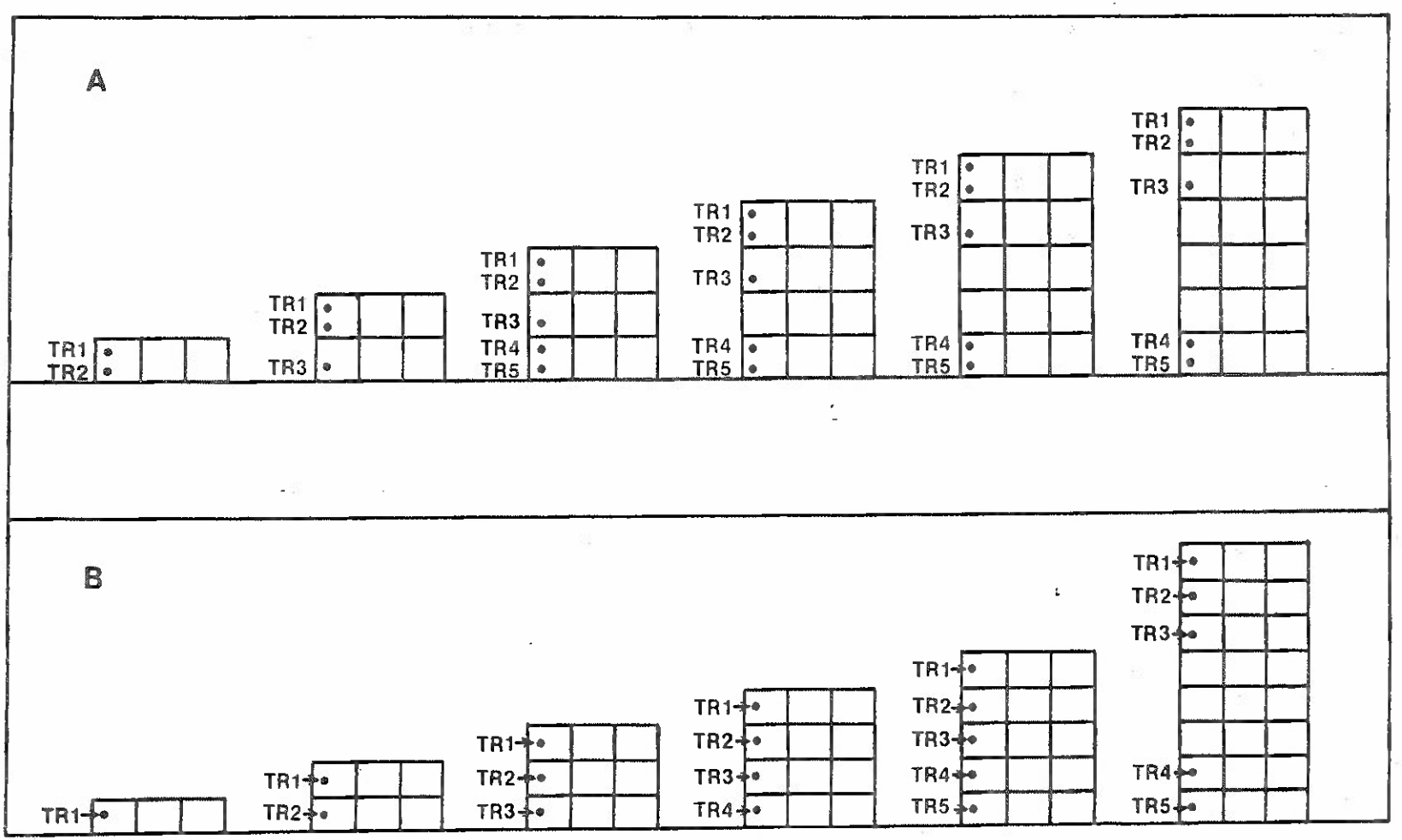


Figure 4. Specific sampling sites for food lots (side view, cross section) in horizontal cabinets suffering mechanical refrigeration failure. A. Food lots of thick packages (those that exceed three inches). B. Food lots of thin packages (three inches or less).

Similarly, write "2" on the next sampling package and "3" to the package underneath the second. Write "4" on the second to the bottom package and "5" on the bottom package. For lots consisting of 4 or less layers, mark the digits on the appropriate TR locations as shown in Fig 4, B.

b. Long Form

A food lot of thick packages as illustrated in Fig. 5, shows sampling location of TRs not only in the outer positions of the corner sampling stacks, which represent not only the S packages, but also a C stack that will require sampling. An equivalent illustration for thin packages is not shown.

## VI. TEMPERATURE READINGS AND DECISION MAKING: SIMPLIFIED FORM

### A. Power Failure of Horizontal Display Cabinets

Temperature readings (TRs) are made by sequentially inserting the thermometer in the locations indicated in Figs. 3 and 4. The thermometer penetration should be such that its tip is no more than one inch from the top and the two sides of the food sample.

Sampling sequence proceeds from the top layer down to the bottom layer. It requires only one TR result above the specification (unacceptable) from both sampling packages at the same level, i.e., either of the TR1's, TR2's or TR3's to condemn the layers they represent. This means that if a TR1 is unacceptable (-), then there is no need to sample the other TR1.

If both TRs of the top sampling packages are acceptable (TR1: ++), then the top layer is acceptable. Since the packages below the top layer could not possibly be warmer than the top layer, the whole lot is acceptable.

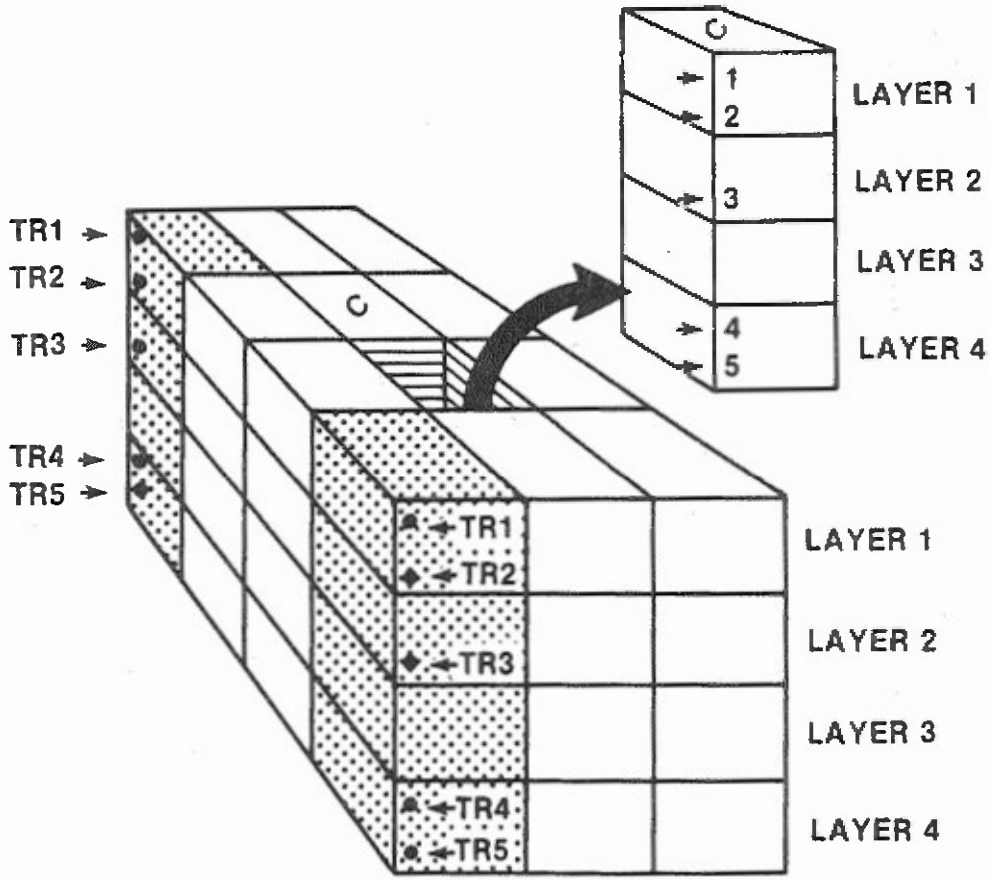


Figure 5. Areas where temperature readings are made from a food lot that consists of 4 or more thick packages per stack.

If one or both of the top sampling packages are unacceptable (TR1: +-/-), but both TRs in locations TR2 are acceptable (TR2: ++), then all packages in the lot but the top layer are saved.

Additional packages of food can be considered as saved by taking into account the protective insulating effect of other lots. Consequently, treat as a large unit two or more lots that are in contact or in an extremely close proximity to each other.

B. Mechanical Failure of Horizontal Display Cabinets

1. Thick Packages

Refer to Fig 4, A for the specific sampling sites. Keep in mind that the sampling sites are in duplicate for each lot. There are five sampling sites (TR1, TR2, TR3, TR4, and TR5) for lots with three or more layers. For lots of one and two layers, there are two and three sampling sites, respectively. As described previously, the thermometer should penetrate each site such that the tip is no more than one inch from the top and the two sides of the food sample.

Refer to Table 3 to determine the scenarios and appropriate decisions for various food lots. Scenarios 1 to 6 are primarily for lots of three or more layers. However, scenarios 1, 3, and 4 are also applicable to two-layered lots while for one-layered lots, scenarios 1 and 3 are applicable. Scenarios 7 and 8 are applicable only for two-layered lots and scenario 8 is applicable only for one-layered lots.

TABLE 3. Scenarios of temperature readings (TRs) of selected portions of a food lot of thick packages and subsequent decisions using the simplified form sampling strategy[a]

| Scenarios[b] | TRs | | | | | Decisions |
|---|---|---|---|---|---|---|
| | TR1 | TR2 | TR3 | TR4 | TR5 | |
| 1 | ++ | ++ | ND[c](++)[d] | ++ | ++ | Save whole lot |
| 2 | ++ | ++ | ND(+-/-)[d] | ++ | ++ | Reject bottom layer |
| 3 | +-/- | ++ | ND(++)[d] | ++ | ++ | Reject top layer |
| 4 | +-/- | +-/- | ++ | ++ | ++ | Reject top two layers |
| 5 | +-/- | +-/- | ++ | ++ | +-/- | Reject top two layers and bottom layer |
| 6 | +-/- | +-/- | +-/- | ND | ND | Reject whole lot |
| 7 | ++ | +-/- | ND | | | Reject lot |
| 8 | ++ | +-/- | | | | Reject lot |

[a]"++" indicates that two samples for TRs did not exceed acceptable temperature limit; "+-/-" indicates that a single TR result is above the temperature limit and that if the first TR result is above the temperature limit, a second TR is unnecessary.

[b]Scenarios 1-5 are applicable to lots consisting of three or more layers. Scenarios 1, 3 and 4 are applicable to two-layered lots; Scenarios 1 and 3 are applicable to one-layered lots.

[c]ND means not determined.

[d]Applicable only to two-layered lots.

2. Thin Packages

Refer to Fig 4, B for the specific sampling sites. The thermometer penetration should be such that the tip is no more than one inch from the sample surface and outer corner of the food sample and equidistant from the top and bottom of the package.

Follow the sequence described in Table 4 starting with Scenario 1. All the scenarios are applicable to lots of four or more layers, with sampling sites limited to TR1 and TR2. For the three layered lot, Scenarios 1 to 4 and 6 are applicable.

If in a four layered lot, TRs 1 and 4 are acceptable, then the whole lot is saved.

If in a six layered lot, TR1 is unacceptable but TR2 and TR5 are acceptable, then only the top layer is rejected. If in addition to TR1, TR2 is also unacceptable but TR3 and TR5 are acceptable, then only the top two layers of the lot are rejected. If TRs 1, 2, and 3 are unacceptable then the whole lot is rejected.

C. VERTICAL DISPLAY CABINETS

In contrast to the complexity of TRs in food products in horizontal cabinets, the sampling strategy for vertical cabinets is much simpler. This is due to the inherent lack of insulation of open vertical cabinets; moreover, there is a low profile stacking arrangement in vertical cabinets.

Before sampling begins, the lot should be of uniform height ("A" configuration) as discussed previously for the horizontal cabinets. The simplified sampling strategy is appropriate for a food lot that has a dimension of three stacks in length by four stacks in width or less. Do a TR on the most exposed section of the top front corner packages. The entire lot is saved if the TR is +, otherwise the lot is rejected.

TABLE 4. Scenarios of temperature readings (TRs) of selected sites in a food lot of thin packages and corresponding decisions (simplified strategy).

| Scenarios | TR1 | TR2 | TR3 | TR4 | TR5 | Decisions |
|---|---|---|---|---|---|---|
| 1 | ++ | ND(++)[a] | ND(++)[b] | ND(++)[c] | ++ | Save whole lot |
| 2 | ++ | ND(+-/-)[a] (++)[b] | ND(+-/-)[b] (++)[c] | ++(+-/-)[c] | +-/- | Reject bottom layer |
| 3 | +-/- | ++ | ND(++)[b] | ND(++)[c] | ++ | Reject top layers |
| 4 | +-/- | +-/- | ++ | ND(++)[c] | ++ | Reject top two layers |
| 5 | +-/- | +-/- | ++ | ++(+-/-)[c] | +-/- | Reject top two layers and bottom layer |
| 6 | +-/- | +-/- | -/- | ND | ND | Reject whole lot |

[a]Applicable only to two-layered lots.

[b]Applicable only to three-layered lots.

[c]Applicable only to four-layered lots.

ND means Not determined

## VII. TEMPERATURE READINCS AND DECISION MAKING: LONG FORM SAMPLING STRATEGY

### A. Power Failure of Horizontal Display Cabinets

This is a more discriminating sampling strategy. The two corner sampling stacks (see darkened stacks in Figure 5) are designated to represent the S packages which are more exposed and are therefore warmer than the C packages; the latter are represented by one sampling C stack. Thick and thin packages are treated alike when power failure occurs.

If the top sampling S packages are unacceptable but the second to the top sampling S packages and the top sampling C packages are acceptable, then only the top S packages are rejected. With the simplified sampling strategy, the whole top layer would have been automatically rejected.

The long form sampling strategy is particularly advantageous when there is a good chance to save a large number of C packages. For instance, if the temperatures of the S packages of a lot are a few degrees above specification, it is likely that the C packages are within specification and are therefore acceptable. In essence, the long form strategy samples food lots not only by layers but also by stacks.

Additional savings can be achieved by taking into account the protective insulating effect of other lots. Consequently, treat as a large unit two or more lots that are in close proximity of each other. As an illustration, Lot A in Figure 6 has one side in contact with Lot B. So in essence, the S stacks of the protected side of Lot A are considered as C stacks except those corner stacks which remain as the outer portion of the larger unit. In the case of Lot B whose two sides are protected by the adjacent lots, A and C, with the exception of the corner stacks, the shielded S packages of both sides of the lot are considered as C stacks.

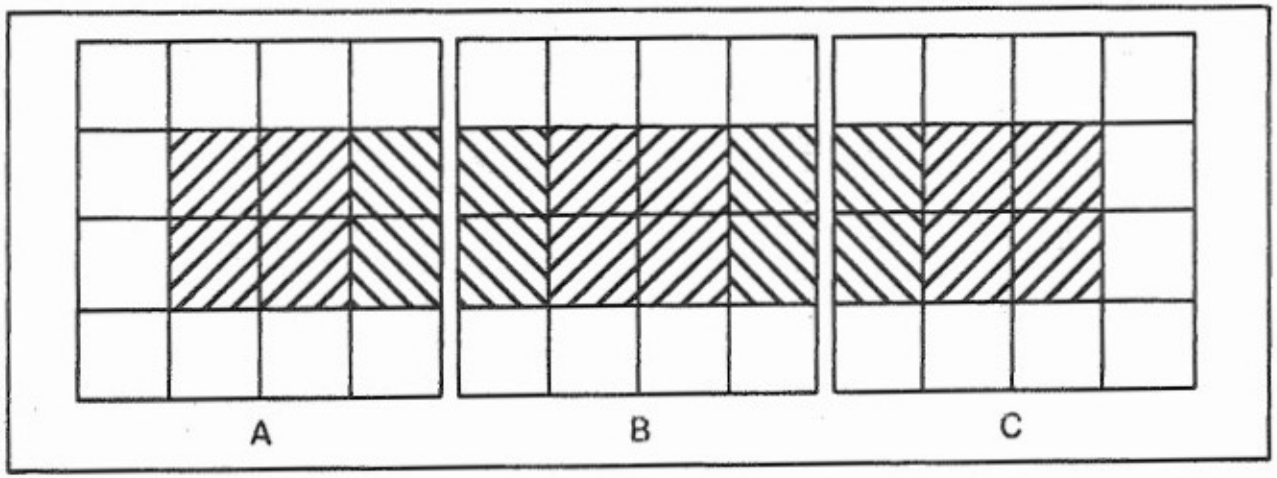


Figure 6. Schematic representation of the food lot situation in a horizontal display cabinet (top view) in regard to the heat shield effect of neighboring food lots. The core stacks are shown as shaded squares.

B. Mechanical Failure of Horizontal Display Cabinets

1. Thick Packages

The sampling atrategy is similsr to the simplified form except that in addition to the two corner sampling stacks that now represent only the S packages, there is also a stack that represents the C packages. Follow the applicable scenarios as shown in Tsble 5.

As an illustration, if s refrigeration failure should occur as indicated in scenario 4, the use of a simplified sampling strategy would reject the top two layers.

2. Thin Packages

This sampling strategy attempts to save additional temperature-abused foods by differentiating the S packages from the C packages. Thus, Table 6 is simply an expanded version of the simplified sampling strategy in Table 4 to accommodate the scenarios of the C packages. There are four subscenarios for scenario 6, differing only in the TRs of their sampling C packages. As described in a previous section, to simplify the sampling procedure lots of similar type of food and size that are next to each other can be combined and treated as one lot.

C. Vertical Display Cabinets

If the dimension of a lot is 4x4 packages or more, the long form sampling strategy is used. This involves dividing the lot into two groups. The side (S) group includes the S packages of the front and back ends and those forming the left and right perimeter of the lot. Those packages surrounded by the S packagea constitute the core (C) group.

TABLE 5. Scenarios of temperature readings (TRs) of selected portion of a food lot of thick packages and subsequent decisions using the long form strategy[a]

| Scenarios[b] | Side(S) Core(C) | TR1 | TR2 | TR3 | TR4 | TR5 | Decisions |
|---|---|---|---|---|---|---|---|
| 1 | S | ++ | ++ | ND[e](++)[c] | ++ | ++ | Save all S packages |
| | C | ND | ND | ND | ND | ND | Save all C packages (C1) |
| 2 | S | ++ | ++ | ND[e] (+-/-)[c] | ++ | +-/ | Reject bottom S packages |
| a | C | ND | ND | ND | ND | + | C1 |
| b | C | ND | ND | ND(-)[c] | ND | - | Reject bottom C packages |
| 3 | S | +-/- | ++ | ND(++)[c] | ++ | ++ | Reject top S packages |
| a | C | + | + | ND | ND | ND | C1 |
| b | C | +-/- | + | ND | ND | ND | Reject top C packages (C2) |
| 4 | S | +-/- | +-/- | ++ | ++ | ++ | Reject top two S packages |
| a | C | + | + | ND | ND | ND | C1 |
| b | C | - | + | ND | ND | ND | C2 |
| c | C | - | - | ND | ND | ND | Reject top two C packages (C3) |

TABLE 5. (Continued) Scenarios of temperature readings (TRs) of selected portion of a food lot of thick packages and subsequent decisions using the long form strategy[a]

| Scenarios[b] | Side(S) Core(C) | TR1 | TR2 | TR3 | TR4 | TR5 | Decisions |
|---|---|---|---|---|---|---|---|
| 5 | S | +-/- | +-/- | ++ | ++ | +-/ | Reject top two S packages and bottom of S packages |
| a | C | + | + | ND | ND | + | C1 |
| b | C | - | + | ND | ND | + | C2 |
| c | C | - | - | ND | ND | + | C3 |
| d | C | - | - | ND | ND | - | Reject top two C packages & bottom C packages (C4) |
| 6 | S | +-/- | +-/- | +-/- | ND | ND | Reject S package |
| a | C | + | + | ND | + | + | C1 |
| b | C | - | + | ND | + | + | C2 |
| c | C | - | - | + | + | + | C3 |
| d | C | - | - | + | + | - | C4 |
| e | C | - | - | - | ND | ND | Reject C packages (C5) |
| 7c | S | ++ | +-/- | ND | ND | ND | Reject S packages |
| a | C | + | + | + | ND | ND | Save C packages |
| b | C | + | + | - | ND | ND | Reject bottom C packages |
| c | C | + | - | - | ND | ND | C5 |

TABLE 5. (Continued) Scenarios of temperature readings (TRs) of selected portion of a food lot of thick packages and subsequent decisions using the long form strategy[a]

| Scenarios[b] | Side(S) Core(C) | TR1 | TR2 | TR3 | TR4 | TR5 | Decisions |
|---|---|---|---|---|---|---|---|
| 8[d] | S | ++ | +-/- | ND | ND | ND | Reject S packages |
| a | C | + | + | ND | ND | ND | Save C packages |
| b | C | + | - | ND | ND | ND | Reject C packages |

[a]"++" indicates that two samples for TRs did not exceed acceptable temperature limit; "+-/-" indicates that a single TR result is above the temperature limit and that if the first TR result is above the temperature limit, a second TR is unnecessary.

[b]Scenarios 1-5 are applicable to lots consisting of three or more layers. Scenarios 1, 3 and 4 are applicable to two-layered lots; Scenarios 1 and 3 are applicable to one-layered lots (underscored).

[c]Applicable only to two-layered lots.

[d]Applicable only to one-layered lots.

ND means not determined

TABLE 6. Scenarios of Temperature Readings of Selected Sampling Sites in food Lots of Thin Packages and Corresponding Decisions (Long Form Strategy)[a]

| Scenarios | Side(S) Core(C) | TR1 | TR2 | TR3 | TR4 | TR5 | Decision |
|---|---|---|---|---|---|---|---|
| 1 | S | ++ | ND(++)[a] | ND(++)[b] | ND(++)[c] | ++ | Save all S packages |
| | C | ND | ND | ND | ND | ND | Save all C packages |
| 2 | S | ++ | ND(+-/-)[a] (++)[c] | ND(+-/-)[b] (++)[d] | ND(+-/-)[c] | +-/- | Reject bottom S packages |
| a | C | ND | ND(+)[a] | ND(+)[b] | ND(+)[c] | + | C1 |
| b | C | + | ND(-)[a] | ND(-)[b] | +(-)[c] | - | Reject bottom C packages |
| 3 | S | +-/- | ++ | ND(++)[b] | ND(++)[c] | ++ | Reject top S packages |
| a | C | + | ND | ND | ND | + | C1 |
| b | C | - | ND | ND | ND | ND | Reject top C packages |
| 4 | S | +-/- | +-/- | ++ | ND | ++ | Reject top two S packages |
| a | C | + | + | ND | ND | ND | C1 |
| b | C | - | + | ND | ND | ND | C2 |
| c | C | - | - | ND | ND | ND | Reject top two C packages (C3) |

TABLE 6. (Continued) Scenarios of Temperature Readings of Selected Sampling Sites in Food Lots of Thin Packages and Corresponding Decisions (Long Form Strategy)[a]

| Scenarios | Side(S) Core(C) | TR1 | TR2 | TR3 | TR4 | TR5 | Decision |
|---|---|---|---|---|---|---|---|
| 5 | S | +-/- | +-/- | ++ | ++(+-1-)[c] | +-/- | Rejects top two S packages and bottom S packages |
| a | C | + | ND | ND | ND | + | C1 |
| b | C | - | + | ND | ND | + | C2 |
| c | C | - | - | ND | ND | + | C3 |
| d | C | - | - | ND | ND | - | Reject top two C packages and bottom C Packages |
| 6 | S | +-/- | +-/- | +-/- | ND | ND | Reject all S packages |
| a | C | + | ND | ND | ND | + | C1 |
| b | C | - | + | ND | ND | + | C2 |
| c | C | - | - | + | ND | + | C3 |
| d | C | - | - | - | ND | ND | Reject all C packages |

[a]Applicable only to two-layered lots.

[b]Applicable only to three-layered lots.

[c]Applicable only to four-layered lots.

ND means Not determined

A TR is made on the most exposed section of one of the top front corner packages (see Figure 7, B). If the TR is +, then the entire lot is saved. If not, do a TR with a C package ($X_2$) and if the TR is +, then the C packages but not the S packages are saved. Lot depth is not considered here since products in open vertical cabinets are not stacked high.

As in horizontal cabinets, if one side of a lot is protected by another, then the S packages on the protected side are considered as C packages except in the case of the corner stacks. If the two sides of the lot are protected by other lots, then S packages are left and right side of the lot are considered C packages except in the case of the corner stacks.

If the food lots that are side by side are of similar size and type of food (e.g., precooked meat entrees) then they can be combined and treated as one lot, reducing the amount of TRs to be taken.

Salvageable items should be put promptly under refrigeration. The retailer may decide whether to refreeze or refrigerate a defrosted item if the concern is product quality.

## VIII. SAMPLING FOR MELT AND SAFE FOODS

### A. Frozen Foods

A similar sampling strategy as described for RISK foods is used for frozen MELT and SAFE foods. However, the main objective here is to separate those items that have maintained their frozen state from those that have thawed. Those items that are still frozen are transferred to a functioning freezer. Defrosted SAFE foods are still considered acceptable and should be transferred to a refrigerator or freezer for resale. The defrosted MELT foods are discarded.

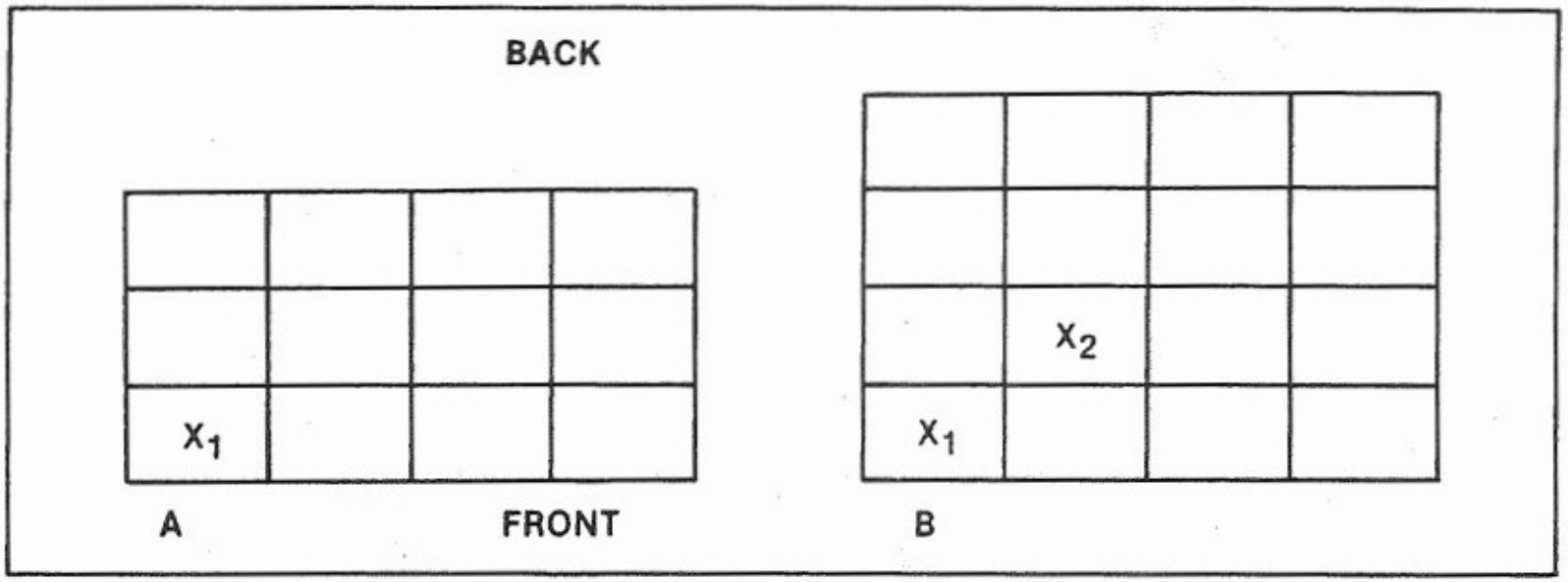


Figure 7. Schematic representation of a top view of food lots on a shelf of an open vertical display cabinet. A. 3 x 4 - package lot, B. 4 x 4 - package lot. X's refer to the sampling stacks.

B. Chilled Foods.

The final temperatures of the most exposed package in a lot of a chilled product are noted, and these packages are transferred to a functioning refrigerator and placed under the responsibility of the commissary manager for a decision as to their marketability.

## Appendix A

### TIME, TEMPERATURE, AND PRODUCT INFORMATION

Time/Date of Refrigeration Failure (RF)_____

Time Interval of RF_____ hrs

Temperature Limits (TL): RISK-1_____ RISK-2_____RISK-3_____

| Product, Description | Food Type:TL | TRs[a] | #Units | # Units Saved |
|---|---|---|---|---|

[a]Temperature Reading